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2. Patent application number
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3. Full name, address and postcode of the or of each applicant *(underline all surnames)*
   MILLIKEN INDUSTRIALS LIMITED
   BEECH HILL PLANT
   GIDLOW LANE
   WIGAN WN6 8RN

   08402364001
   Patents ADP number *(if you know it)*

   If the applicant is a corporate body, give the country/state of its incorporation
   ENGLAND

4. Title of the invention
   MAT MANUFACTURING PROCESS.

5. Name of your agent *(if you have one)*
   STEPHEN BRISTOW

   "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*
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   WN6 8RN

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

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11. I/We request the grant of a patent on the basis of this application.

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Date 12 June 2002

12. Name and daytime telephone number of person to contact in the United Kingdom

STEPHEN BRISTOW
01942 61 2959.

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9236

MAT MANUFACTURING PROCESS

Technical Field

This invention relates to a process for the manufacture of rubber backed mats, in particular to a process for manufacturing tufted pile textile surfaced rubber backed mats.

Background to the Invention

Rubber backed mats are used as floor mats and as bar runners or drinks mats. Rubber backed floor mats compete with other floor mat products that are sold through three different trade channels and which have different user requirements. These floor mats can be considered in three categories based on the trade channels. The categories are retail, commercial and industrial or rental. Although rubber backed mats have enjoyed much success in the industrial category where their high performance is a requirement, their market penetration in the other categories has been hampered by their relatively high cost coupled with the generally lower performance requirements of those markets.

Rubber backed mats typically have a tufted pile textile surface which provides excellent dirt trapping performance, has considerable aesthetic appeal and can be provided with colours and designs to suit customer requirements and tastes.

A process for the manufacture of rubber backed matting is described in EP 0 367 441. This process typifies processes used for the manufacture of industrial mats and includes the steps of placing a rubber sheet/mat assembly between a hot platen and a pressure applying arrangement with the rubber sheet adjacent the hot platen, wherein the pressure applying arrangement comprises a fluid pressure arrangement in the form of an air bag. A release material, which may be textured, may be provided between the rubber sheet and the hot platen. The preferred construction for the release material is a P.T.F.E. coated woven glass fibre sheet. The cure temperature for nitrile rubber is taught to be in the range 150 to 160°C and the time for cure is 5 to 10 minutes. A suitable pressure in the airbag is said to be one atmosphere above atmospheric. A problem with making tufted pile textile surfaced mats using this process is that the pile is crushed during the manufacturing process due to the relatively high temperatures and pressures required to vulcanize the rubber and bond it to the textile surface. The crushed pile effects the quality of the feel and performance of the textile surface. This is not a major problem when selling mats to the industrial/rental market because the mats are washed and dried before use and the pile is thereby restored. Mats supplied to the commercial and retail markets are desirably not washed before sale as this is a waste of energy and in many cases would be made difficult by non-washable point of sale packaging and identification affixed to the product during the manufacturing process. The problem of pile crush is particularly severe when polypropylene yarn is used in the tufts. Indeed

the use of polypropylene yarns in these types of mats is almost zero as a direct result of this problem.

Many processes for the use of recycled rubber waste, such as old tyres have been proposed. Among them may be particularly mentioned the following processes to produce sheet articles from rubber waste that has been reduced to crumb.

GB 2035336 describes a method for the reclamation of waste rubbers in which rubber crumb (e.g. from tyre waste) of size 20s mesh or finer is mixed in an amount up to 90% by weight with an adhesive and the mixture is cured, possibly under externally applied heat and or pressure. The preferred adhesives are urethane pre-polymers that are isocyanate rich. Pre-polymers formed from polyether triols or other polyether polyols reacted with 2,4-tolylene diisocyanate or 2,6-tolylene diisocyanate (TDI) or 4,4'-diphenyl methane diisocyanate or hydrogenated 4,4'-diphenyl methane diisocyanate or 4,4'-dicyclohexyl methane diisocyanate (MDI) in an 80/20 mix are taught. The optimum cure temperature is said to be in the range 160°C to 200°C. Finer crumb is said to make better solid rubber products; 40s mesh being preferred.

EP 0135595 describes a method for manufacturing a floor covering in the form of a web. The method consisting of continuously applying and evenly spreading over a rotating endless belt conveyor, a layer of disintegrated waste rubber and/or granules of new or scrap rubber which has been mixed with a pre-polymer as a solvent-free single-component binder, of which the reaction has already been triggered. The layer is then compressed onto the belt. The compressed layer is passed through a heated chamber where it is cured. In one embodiment the crumb rubber is spread onto and cured in contact with a textile or carpet layer. This textile layer then forms the base of the product. It is suggested to use the product as a sports surface.

DE 4113056 is a process for recycling products from fresh rubber scrap, old tyres, or other elastomer scrap. The products to be recycled are made into granules, strips or powder, mixed with suitable hard-setting binders and cured in a press.

DE 4212757 describes a moulded component forming an elastic layer and comprising a mixture of granulated recycled material and binders. The component has three compressed layers of uniform thickness bonded together at their interfaces. Upper and middle layers are formed by flat plates and the lower layer has hump-shaped feet separated by grooves. The individual layers are formed in different materials with different particle sizes. The component can be used as a covering e.g. for floors.

DE 4212765 describes a processing plant for recycling materials made of fresh rubber scrap, used rubber, used tyres or other elastomer scrap. The material concerned is taken in the form of granules, strips or powder and mixed with suitable thermosetting binders and cured in a press. The recycled material and binders are added separately to a mixing chamber containing a longitudinal feeder shaft; the chamber has a narrow outlet, beyond which the plant has a vertical

spreader with a tapered lower end and a pressurising screw. A continuous conveyor belt beneath the spreader passes through a hot press with a lower platen, a vertically moving top pressure platen, and a system of pressure rams and plates at the sides which presumably constrain the recycled material from lateral movement as it is compressed.

Throughout this specification the term crumb has the normal meaning in the rubber industry of any "broken down" rubber; thus a crumb of elastomer can be any size in a range which may include powder, granules and chips. In this specification powder means crumb that will pass a 2mm mesh or crumb with a maximum diameter of 2mm as the context requires. Granule means crumb that will pass a 6mm mesh or crumb with a maximum diameter of 6mm as the context requires. Granules may include some powder but normally granules should have a weight average size that is near to the maximum of the size specification for the granule. Chips means crumbs larger than granules.

Disclosure of Invention

According to the present invention there is a process for the formation of a mat having a rubber backing and a tufted pile textile surface including the steps of:

a) mixing a quantity of rubber crumb and a binder,

b) forming the binder and rubber crumb into an unset crumb layer thicker than the desired backing thickness, the unset crumb layer also including void space which is neither rubber nor binder; then

c) using a combination of at least one hot compression and at least one cooler compression to set the binder whilst the crumb layer is under compression, thereby to bond the crumbs together to form the rubber backing and to reduce the void volume to 10 to 40% of the rubber backing.

By the selection of temperatures and pressures which leave more than 10% voids in the rubber backing it is possible to use tufted pile surfaces which do not suffer from undue pile crush during the manufacturing steps.

Desirably the hot compression is carried out at a temperature in the range 80 to 200°C, preferably 110°C to 140°C and most preferably about 125°C. By selection of temperatures which are lower than those used for the vulcanization of the rubber used in the conventional mat making processes the amount of pile crush due to the yarns or fibres deforming and setting with heat is reduced.

Advantageously the maximum pressure used for the compressions lies in the range 3 to 40psig. By selection of lower pressures the pile crush is further reduced. The limiting factor is that the use of very low pressures will lead to a loss of strength in the rubber backing which can be a particular problem for mats which have exposed rubber border areas.

The preferred process comprising at least one cool compression followed by at least one compression significantly hotter than the cool compression, this is needed when the binder is selected from the group comprising thermosetting and water curable polymeric materials and mixtures thereof. The cool compression should be at a low enough temperature to avoid setting of the binder, whereas the hotter compression should be hot enough to substantially set then binder.

An alternative process may be used when thermoplastic hot melt binders are employed. In this variant the process comprises at least one hot compression followed by at least one compression significantly cooler than the hot compression. Suitable hot melt binders are selected from the group comprising thermoplastic polymeric materials and mixtures thereof. In this variant the hot compression should be hot enough to melt the binder and the cooler compression cool enough to allow the binder to set.

In addition to formation of the rubber backing the compression also provides enough contact between the binder and the lower surface of the tufted pile textile to provide a good adhesion between the textile surface and the backing.

It is preferred, especially for long pile or for mats with exposed rubber borders for the pressure to be applied by means of a pressure transferal means which substantially equalizes the pressure applied across the mat. This pressure transferal means may be a fluid filled containment. Silicone gel or air are preferred fluids. Advantageously the containment is a silicone rubber coated fabric bag.

Also according to the present invention there is a process for the manufacture of a mat with a rubber backing and a textile surface including the steps of:

a) mixing rubber crumb and binder together,

b) spreading the mixture of rubber crumb and binder as a rubber crumb layer, the layer being contained between a belt and the back surface of a tufted pile textile,

c) moving the belt to progress the crumb layer and the textile through a press, which is at least partially heated; and

d) using a fluid filled containment within the press to compress the rubber crumb to form a rubber crumb backing layer bonded to the textile to form the rubber backed mat.

The process may advantageously be carried out in a variant whereby the pile surface of the textile pile layer and the surface of the rubber crumb layer remote from the textile layer are contained by first and second belts, the first and second belts moving at the same time to progress the mat through the press.

The rubber crumb is preferably nitrile rubber crumb. The thickness of the rubber crumb layer before compression may be between 150 and 250% of the eventual thickness of the rubber backing.

Mat borders may be produced by spreading the crumb over a larger area than the textile. The borders may be produced around all the edges of the mat by feeding the mats onto the layer of crumb from a dispensing means that spaces the mats sufficiently to produce the required borders.

The heated press may operate on a quasi-continuous basis so that the mat advances through the press in a number of equal increments corresponding to a number of zones in the press and after each advance pressure is applied to the mat assembly.

The pressure may applied by means of an air bag that extends across all the zones of the press. This provides the advantage that when inflated the pressure extends across the hotter and cooler zones which reduces the likelihood of ridges being formed in the mat backing due to application of pressure to a localised area. It also allows pressure to be properly applied to the borders and to the transitional zone between the textile layer and the border. The use of an air bag to provide the pressure gives the added benefit that there are no problems caused by the variable thickness of the backing from one product to another, nor the reduction in thickness during curing, nor the variation in textile layer thickness from one product to another. All these factors are not a problem for processing because a consistent pressure is always applied across the mat and its border. This has been found to be very important for rubber crumb backed mats.

At least one zone of the press is not directly heated. This will be the first zone when thermosetting binders are used and a subsequent zone or zones when thermoplastic binders are being used. For thermosetting binders the first application of pressure is therefore done at lower temperature than that which is used in the subsequent zones. This is important to allow the rubber crumb to move into a compact arrangement before the binder is cured. The subsequent applications of pressure cure the binder. Moving the mat assembly between each application of pressure ensures that pressure ridges are not formed in the backing layer.

Advantageously a first zone of the press is not heated. Most advantageously the temperature of the heated zone or zones is more than 20°C below the temperature at which nitrile rubber would vulcanize when pressed for the same time. The pressure in all the zones during the pressure part of the cycle is between 3 to 10 psig. A big advantage of this invention over conventional vulcanizing of a rubber backing is that lower temperatures and pressures may be used. Besides the obvious energy saving this also means that there is less pile crush than with a conventional process so the original pile height can be reduced to save weight or the mat can be made to have a superior appearance when compared with a conventional rubber backed mat or the need for a final washing step is eliminated.

The invention also provides a process for the manufacture of a mat with a rubber backing and a textile surface including the steps of:

a) mixing rubber crumb and binder together,

b) spreading the mixture of rubber crumb and binder as a rubber crumb layer which is in contact with the textile surface,

c) using a press to compress the rubber crumb to form a rubber crumb backing layer bonded to the textile to form the rubber backed mat, characterised in that during compression there is no lateral constraint of the rubber crumb layer.

Additives may be mixed with the crumb during the mixing process. Suitable powdered additives may be selected from anti microbial materials, anti flammability additives, odorants, colorants or pigments such as iron oxide powder, anti-static additives, such as carbon fibres, fillers, plasticisers and other generally known powdered additives. Additives may also be added to the mix by premixing them with the binder. Other ingredients may also be introduced to the backing in either solid or liquid form due to the flexibility of the process. Flame retardants are a particularly preferred class of additives as they boost the already good performance of rubber crumb backings made according to this process.

The binder is preferably MDI polyurethane one component (moisture curing) adhesive. In a particularly preferred embodiment to promote faster curing of the binder steam may be introduced to the press, or directly before the press, to ensure that the binder is in contact with the necessary moisture.

The binder level is desirably in the range 2 to 12% by weight of the elastomer crumbs when granules or chips are being used. When powder is used the amount of binder should lie in the range 9% to 20% by weight, preferably about 12%.

Alternatively the binder may be a hot melt binder used at a level of 5 to 15%.

A further advantage of this process is that it allows the backing size to be determined on the spot. Use of sheets of pre-calendared unvulcanized rubber necessitates large stocks of sheets for different sizes or a cutting operation, neither of which is entirely satisfactory.

The mat produced by this process is suited to the retail and commercial market segments. This backing process and backing may also be used for products designed to be used on tables or counters, so long as limited washability is acceptable for the product use. The process can also be utilized to make products such as anti-fatigue mats as the compressibility of the backing material can be adjusted by choice of the size of crumb, the type and amount of binder used, and the pressure applied during the process.

The rubber crumb

The rubber crumb may be selected from all types of rubber or equivalent deformable hard and durable elastomers. The preferred type of rubber is nitrile rubber, which may conveniently be obtained by deconstructing industrial or rental mats. The mats are preferably nitrile rubber backed, nylon tufted, mats. Other sources of vulcanized nitrile rubber may be used as the source of the rubber crumb. Industrial or rental mats are preferred because the nitrile rubber in such mats is specially formulated to have low bleed and staining properties and this makes them especially suitable as the source material for commercial or retail mat backing.

Nitrile rubber is a term used to describe a compounded rubber mixture of which the main polymeric content is an acrylonitrile butadiene copolymer. It may also contain fillers such as carbon black, a curing system, plasticisers and other ancillary components.

The crumb may include some flock from the textile surface of the original mat. Perhaps in bonding relationship to the crumb. The flock content should be as low as possible, preferably less than 10% by weight.

The crumb size may range from about 0.01 to 8 mm. Generally, to reduce the processing costs and binder quantities. The size will be selected to be as large as possible for the use and properties required. A crumb that passes a 4 mm aperture screen has been found to be useful for floor mats. Crumb size can be chosen to give different amounts of resilience in the mat. The larger the crumb the greater the resilience.

Crumb may be mixed with powder of the same material or a different material to provide a greater tear resistance. The powder increases the tear strength for a given binder level. The use of other additives in powdered form provides the same advantage.

The binder

The binder is selected as either a heat setting or thermoplastic type. Depending on the process utilized the binder can be in liquid or powder form. Preferably the binder is selected from one of the following types, Polyurethane reactive hotmelts, Copolyester or copolyamide reactive and thermoplastic hotmelts, 4,4-methylene di-p-phenylene isocyanate (MDI) polyurethane one component (moisture curing) and two component adhesives.

It is important that the binder has good adhesive properties to ensure that the crumb is well bound and that sufficient free binder is capable of forming a physical or chemical bond to the textile surface. The binder should also exhibit sufficient cohesive strength to give the backing sufficient strength. The binder is one that cures or sets at a sufficiently low temperature and pressure that pile crush is substantially avoided

The binder may contain any of the known cross linkers or curing accelerators to suit the process and the desired properties of the mat being manufactured and the rubber being used.

The binder performs the dual function of holding together the crumb backing and bonding the backing to the textile surface of the mat. To perform both functions adequately we have found that binder levels should be in the range 2 to 12% by weight of the crumbs when chips or granules are being used. Use of less than 2% gives a very poor tensile strength in the backing. Use of greater than 12% gives a stiff backing and a skin forms. This reduces the bond strength between the backing and the textile surface. When rubber crumb powder is also added to the backing the amount of binder needed for optimal properties is greater due to the higher surface area of the rubber crumb powder on a weight for weight basis. For powders, especially finer rubber crumb powders of size less than 0.5mm the binder range should lie in the range 9 to 20%, preferably about 12%. Because the powder addition increases the tensile strength a little powder can improve the tensile strength of the backing without increasing the binder content. The general rule is that a change in crumb size should be reflected in a corresponding inverse change in binder content.

The binder may be a liquid polyurethane MDI binder present at a level of from 4 to 12%. The binder may contain further additives such as colorants that are in liquid form and are compatible with the binder, such as plasticisers and perfumes. The binder may also contain other additives such as those listed as crumb additives provided that they are suitable for addition in a liquid medium.

The binder may also be a thermoplastic or thermosetting hot melt powder present at a level from 5 to 15%. A powdered binder may also contain other additives such as those listed as crumb additives provided that they are suitable for addition in a powder medium. The advantage of using hot melt binders in this process is that they remain "dry" until they are subjected to heat. This means that the batch of rubber crumb and binder will not set before it is used. It also provides for easier spreading of the layer of crumb as the level of tack in the crumb and binder mixture is lower than in the case of thermosetting systems such as MDI.

MDI is a preferred thermosetting binder as it can give the best tuft lock to the tufting substrate of a pile faced mat. The degree of tuft lock can be engineered by altering the amount of binder in the mix. This is advantageous as it gives a control over the delamination properties of the mat. The thermosetting binders may also include a processing or extender oil to regulate the viscosity. These processing oils may be aromatic or aliphatic. Processing oils should be non-staining, light coloured and have low volatility. It is preferred not to use an extender oil or solvent in the binder.

Mixing trials have identified preferred mixing methods, particularly for the powders, which require high speed, high shear, mixing to ensure the binder is evenly distributed within the powder. The model used for the trials is a Winkworth RT style that combines a slow (100-200 rpm) "dough" style blade with a high-speed (3000 rpm) knife refiner.

The invention will now be further described by way of example only and with reference to the drawings, which are briefly described as:

Figure 1 is a side view of a backing mixer and a mat manufacturing press.

Figure 1 shows the process for making a new commercial or retail mat with a rubber crumb backing. Rubber crumb in the form of granules 15 or powder 16, or a mixture thereof, is conveyed and metered to a mixer 17. Mixing is in this embodiment a batch process. For some applications a continuous mixing process would be preferred due to the lower amount of mixed material present in such a continuous system. After the granules 15 or powder 16 have been charged to the mixing chamber the mixer 17 is run. A MDI binder 18 is metered into the mixer 17. The mixer 17 is then run for a further 5 minutes. The MDI 18, once exposed to the moisture in the atmosphere will start to set and should be used within 1 to 3 hours.

Powder requires about 11% MDI binder and granules about 7% MDI binder based on weight of rubber. When using powder after the powder is added to the mixer, the mixer is run for about 1 minute to evenly disperse the powder then the MDI binder is added and the mixer 17 is run for a further 4 minutes.

After mixing the rubber granules 15 and/or rubber powder 16 with the MDI 18 the batch is transferred to a scatter-coater 19. The scatter coater spreads a layer of rubber crumb 25 onto a PTFE coated glass fibre belt 22. The width of the layer is set to be slightly wider than the desired eventual width of the matting roll or mats (or the length of the mats if they are being perpendicular to the direction of process travel).

To manufacture the mats, a tufted pile textile 20 comprising a tufting substrate and a textile pile tufted into the substrate is led from a roll 21 on to the layer of rubber crumb 25. The tufted pile textile 20 has its pile surface facing upwards and away from the rubber crumb 25. A press 23 contains a second PTFE coated glass fibre belt 24 above the textile 20. The two belts 22 and 24 form the outer skins of a sandwich between which is the scatter coated rubber crumb 25 and the textile 20. This sandwich is moved into the press 23 by simultaneous and synchronized movement of the belts 22 and 24.

For mats with a border around the entire periphery or mats not made from a roll of textile a series of suitably sized pieces of textile are laid onto the layer of rubber crumb 25 in such a way that sufficient gap is left between each piece of textile for the borders when they are required. The press 23 consists of a heated platen 26 located in the lower half of the press 23 and an air inflated diaphragm or air bag 27 in the upper part of the press 23. The diaphragm 27 is designed to put pressure onto the sandwich 28 between belts 22 and 24. Belts 22 and 24 are located between the platen 26 and diaphragm 27.

The cycle of the press 23 is as follows: The belts 22, 24 are advanced in synchronism a portion of the length of platen 26. Compressed air (not shown) then inflates the diaphragm or air bag 27

onto the sandwich 28. After about one minute the compressed air is vented to atmosphere and a slight vacuum is applied to the diaphragm 27 to pull it away from the sandwich 28. The cycle then repeats.

The first zone 29 of the press 23 is not directly heated and is therefore not at such a high temperature as the remainder of the press. Thus at first the sandwich 28 and thus the crumb rubber backing is compressed but the temperature at which the binder will cure quickly is not reached. As it advances through the subsequent zones the sandwich is both compressed and heated and this cures the binder which sets the backing and bonds it to the textile 20. Using this process the mat 30 is made with no joins or pressure induced lines.

As the mat 30 exits the press 23 it is wound onto a roll 31, or alternatively it is first trimmed.

A variation of the process is required when a thermoplastic or hot melt binder is used. In this case the first zone of the press is heated to melt the binder and the subsequent zones are cooler to allow it to be set under pressure to form the backing and to bond the textile to the backing.

Other variations of the process are possible in which the textile is placed face down and then the rubber crumb and binder is spread over it to form the backing through application of heat and pressure. The level of heat and pressure application is the same as for the processes already described with reference to having the textile surface upwards. It is normally preferred for the heated platen to contact the belt on the side of the backing and for the air bag to contact the belt on the side of the textile as this means that minimum temperature is applied to the yarns making up the textile. This is advantageous if those yarns are affected by heat.

Example

A batch of 1-4mm nitrile rubber crumb was mixed with 8% MDI binder. The mixture was divided up and sample rubber mat backings were made by spreading the crumb mixture evenly with a thickness of 8mm and then pressing the mixture using an air bag press at various pressures to produce a series of samples. The pressure ranged from no pressure in the air bag through to 45 psig. All the rubber backing samples so formed were cured at 125°C for 10 minutes. A 25mm square section was then cut from each sample and its thickness and weight was measured. From this the density of the sample was determined. The data is given in table 1.

Table 1 -Density Test Data

Sample ID	Pressure psig	Width mm	Length mm	Thickness mm	Weight g	Volume cm^3	Density g/cm^3
A	0	25	25	8.1	2.8	5.06	0.55
B	2	25	25	6.2	2.8	3.87	0.72

C	4	25	25	5.4	2.6	3.37	0.77
D	8	25	25	5.4	2.9	3.37	0.86
E	16	25	25	5.0	3.2	3.12	1.02
F	32	25	25	4.3	2.8	2.68	1.04
G	45	25	25	3.9	2.7	2.43	1.11
Compress		25	25	7.3	5.0	4.56	1.10
Rubber							1.22

It can be seen from Table 1 that the density increases as the pressure applied increases. The maximum density achieved was 1.1 g/cm^3. Theoretically if the backing sample were 100% compressed the density would be about 1.22 g/cm^3 to match the conventional vulcanized mat backing. The mat labeled "Compress" is a prior art mat available commercially which is formed by compression-moulding rubber crumb to form a very dense backing. From the table it can be seen to be about the same density as we obtained using a 45psi pressure in our air bag process. The use of no pressure forms an unsatisfactory backing with low strength.

Table 1 also gives a general view of the reduction in backing thickness from around 8mm before to 4 to 5mm after pressing.

The samples were then tested to determine their deformability. This test is done with a thickness gauge with a 12 mm^2 end. Weight is applied to the measuring plunger of the thickness gauge. First the new backing thickness is measured with 100g weight and then the thickness is re-measured with a 1000g weight. The deformability is the percentage fall in the thickness at 100g loading when the loading pressure is increased to 1000g.

Table 2 - Deformability test data.

Sample ID	Pressure	100g	1000g	Deformability %
A	0	7.65	4.0	47.7
B	2	5.70	4.3	24.6
C	4	5.10	4.2	17.6
D	8	5.30	4.55	14.2

E	16	4.80	4.3	10.4
F	32	4.15	3.75	9.6
G	45	3.70	3.5	5.4
Compress		7.45	7.05	5.4
Rubber		6.10	5.6	8.2

From table 1 it can be seen that there is a correlation between formation pressure and density. From table 2 it can also be seen that there is a correlation between pressure (density) and compressibility. The higher the formation pressure the higher the density and the higher the density the lower the compressibility.

The comparative sample labeled "Rubber" is a conventional rubber backed industrial or rental mat, which is included for reference purposes. It is softer and therefore more deformable than the high pressure crumb backings because of the presence of binder in the latter. The binder material is relatively hard, compared with vulcanized rubber.

With the prior art compression molded mat, the density of the mat is in the range of 80-95% of the density of the material from which the crumb was made. The backing is also harder material than the material from which the crumb was made because of the binder. By using the process according to the invention, the density can be varied to lie within 50-80% of the density of the material from which the crumb was made. This offers the advantage of a lighter-weight mat which is more easily washed and dried and which is easier to carry and transport whilst still being a rubber backed mat. This also has the advantage that product density can be varied by a minor process change to enable production flexibility. Additives could also be included in the crumb and binder mix to further control or change the density if required.

<u>Sand Retention Tests.</u>

For this test two equal size samples of a mat (0.05781 m^2) are cut out. Each sample is weighed. They are then fixed to the inside of a tetrapod chamber and 1000 g of dry sand is added along with five golf balls to provide agitation. The chamber is then sealed and set revolving for 1000 revolutions. On completion of the test each sample is removed and the weight recorded. The amount of sand retained in each sample is then calculated and expressed as the amount of dry sand retained in g/m^2.

Two mats with identical pile construction were subjected to this test

Mat A was a Tufted Nylon Cut pile conventional rubber backing which had been fabricated in an air bag press at 165°C and 30 psi.

Mat B was a Tufted Nylon Cut pile with a rubber crumb backing which had also been fabricated in an air bag press but at a lower temperature and pressure. The sand retention results were as follows:

Sample of prior art conventional rubber backed mat A = 723 g/m^2

Sample of crumb rubber backed mat according to the invention mat B = 2655 g/m^2

Production of e a conventional rubber backed mat significantly flattens the pile on the mat. Use of the lower temperature and pressure possible when using the same type of air bag pressurised, heated platen equipment to produce a rubber crumb backed textile pile faced mat does not. This gives a mat, which immediately after manufacture has good dust control properties without being laundered. This good dust control performance is exemplified by a sand retention value in excess of 1000 g/m^2, even in excess of 2000 g/m^2. The uncrushed pile also exhibits better "feel" by way of a more luxurious texture.

Claims

1. A process to manufacture a mat with a rubber crumb backing and a textile surface which process includes the steps of:

   a) mixing a quantity of rubber crumb and a binder

   b) forming the binder coated rubber crumb into an unset crumb layer thicker than the rubber crumb backing, the unset crumb layer also including void space which is neither rubber nor binder

   c) then using a combination of at least one hot compression and at least one cooler compression to set the binder whilst the crumb layer is under compression, thereby to bond the crumbs together to form the rubber crumb backing and to reduce the void volume to 10 to 40% of the mat backing.

2. A process according to claim 1 in which the hot compression is carried out at a temperature in the range 80 to 200°C, preferably 110°C to 140°C and most preferably about 125°C.

3. A process according to claim 1 in which the pressure for each compression step lies in the range 3 to 40psig.

4. A process according to claim 1 comprising at least one cooler compression followed by at least one hot compression and the binder is selected from the group comprising thermosetting and water curable polymeric materials and mixtures thereof.

5. A process according to claim 1 comprising at least one hot compression followed by at least one cooler compression and the binder is selected from the group comprising thermoplastic polymeric materials or hotmelt binders and mixtures thereof.

6. A process according to any preceding claim in which a layer of textile material is bonded to the mat backing during the hot and cool compressions which form the mat backing.

7. A process according to any preceding claim in which the textile surface is a tufted pile textile.

8. A process according to any preceding claim in which the pressure is applied by means of a pressure transferal means, which substantially equalizes the pressure, applied across the area of the backing to which it is applied.

9. A process according to claim 8 in which the pressure transferal means equalizes the pressure applied in each simultaneous compression step.

10. A process according to claim 8 or 9 in which the pressure transferal means is a fluid filled containment.

11. A process according to claim 10 in which the fluid is air.

12. A process according to claim 10 in which the containment is a PTFE coated fabric air bag.

13. A process for the manufacture of a mat with a rubber backing and a textile surface including the steps of:

    a) mixing rubber crumb and binder together,

    b) spreading the mixture of rubber crumb and binder as a rubber crumb layer, the layer being contained between a belt and the back surface of a tufted pile textile,

    c) moving the belt to progress the crumb layer and the textile through a press, which is at least partially heated; and

    d) using a fluid filled containment within the press to compress the rubber crumb to form a rubber crumb backing layer bonded to the textile to form the rubber backed mat.

14. A process according to claim 13 wherein the pile surface of the textile pile layer and the surface of the rubber crumb layer remote from the textile layer are contained by first and second belts, the first and second belts moving at the same time to progress the mat through the press.

15. A process according to claim 13 or claim 14 in which the fluid filled containment is an air bag

16. A mat manufacturing process according to any one of claims 13 to 15 in which the rubber crumb is nitrile rubber crumb.

17. A mat manufacturing process according to any one of claims 13 to 16 in which the thickness of the crumb layer before compression is between 150 and 250% of the eventual thickness of the mat backing.

18. A mat manufacturing process according to claim 13 in which mat borders are produced by spreading the crumb over a larger area than the textile.

19. A mat manufacturing process according to claim 18 in which borders are produced around all the edges of the mat by feeding the mats onto the layer of crumb from a dispensing means which spaces the mats sufficiently to produce the required borders.

20. A mat manufacturing process according to claim 13 in which the heated press operates on a quasi-continuous basis so that the mat advances through the press in a number of equal increments corresponding to a number of zones in the press and after each advance pressure is applied to the mat assembly.

21. A mat manufacturing process according to claim 20 in which the pressure is applied by means of an airbag which extends across all the zones of the press.

22. A mat manufacturing process according to claim 20 or claim 21 in which the first zone of the press is not heated.

23. A mat manufacturing process according to claim 13 in which the temperature in the press is more than 20°C below the temperature at which nitrile rubber would vulcanize when pressed for the same time.

~~24. A mat manufacturing process according to claim 13 in which the pressure in the press during~~ the pressure part of the cycle is between 3 to 40 psig, preferably 3 to 10 psig.

25. A mat manufacturing process according to claim 13 in which additives are mixed with the crumb during the mixing process, the additives being selected from: powdered nitrile rubber, anti-static agents, antimicrobials, odorants, colorants, plasticisers, and fillers

26. A mat manufacturing process according to claim 13 in which the rubber crumb is mainly rubber from recycled industrial mats.

27. A mat manufacturing process according to claim 13 in which the crumb size is in the range 4 to 6mm.

28. A mat manufacturing process according to claim 13 in which the binder is MDI polyurethane one component (moisture curing) adhesive.

29. A mat manufacturing process according to claim 13 in which steam may be introduced to the press, or directly before the press, to ensure that the binder is in contact with the necessary moisture.

30. A mat manufacturing process according to claim 13 in which the binder level is in the range 2 to 12% by weight of the elastomer crumbs when coarse granules are being used.

31. A mat manufacturing process according to claim 13 in which powder of size greater than 0.5mm is also added to the backing mixture and the amount of binder added lies in the range 9% to 20% by weight, preferably about 12%.

32. A mat manufacturing process according to claim 13 in which the binder is a thermoplastic material which is not tacky at ambient temperature.

33. A mat manufacturing process according to claim 32 in which the binder is a hot melt adhesive.

34. A process for the manufacture of a mat with a rubber backing and a textile surface including the steps of:

   a) mixing rubber crumb and binder together,

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b) spreading the mixture of rubber crumb and binder as a rubber crumb layer which is in contact with the textile surface,

c) using a press to compress the rubber crumb to form a rubber crumb backing layer bonded to the textile to form the rubber backed mat, characterised in that during compression there is no lateral constraint of the rubber crumb layer.

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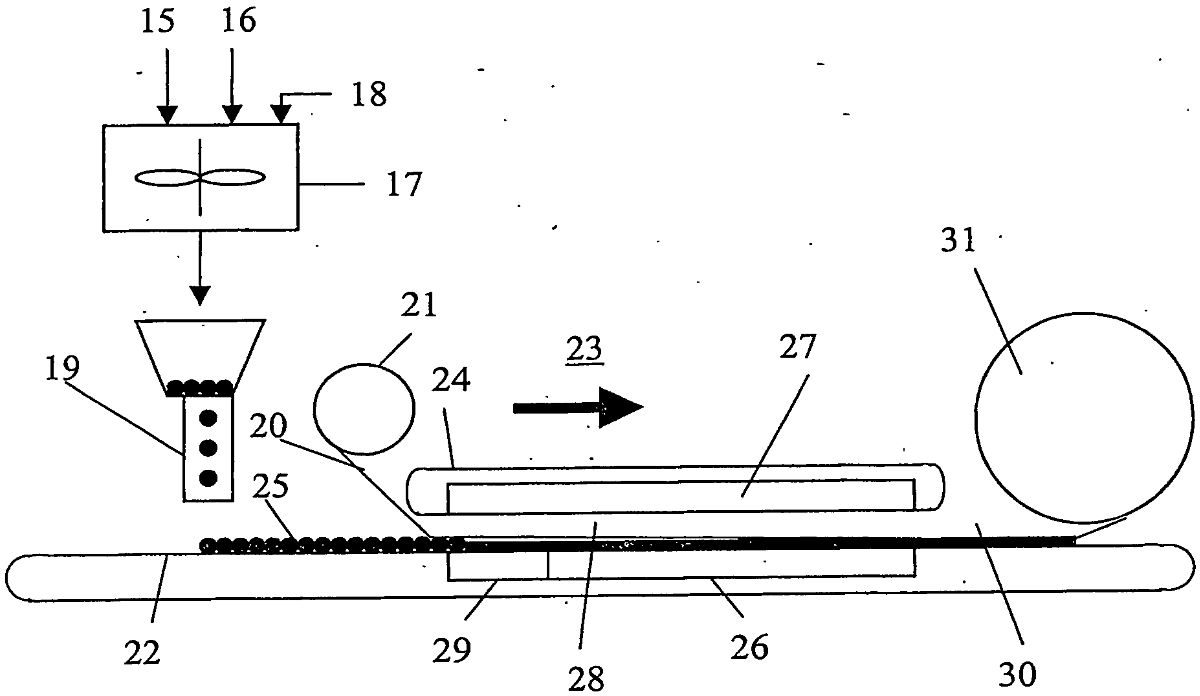

Fig 1